

WHAT IS CLAIMED IS:

1. A process for applying a paint coat, suitable for
5 exterior automotive use, to a plastic exterior body panel of a
motor vehicle, characterized by the steps of:

10 applying a clear coat (45) of a synthetic resinous
material in thin film form onto a surface of a flexible casting
sheet (42), and drying the clear coat on the casting sheet, the
surface of the sheet having a specular reflectance for
transferring to the surface of the dried clear coat a gloss level
sufficient for exterior automotive use;

15 forming a color coat (46) of a pigmented synthetic
resinous material which is dried and adhered to the clear coat;

20 transferring the dried clear coat and color coat to a
semirigid backing sheet (72) of a synthetic resinous material to
form a composite paint coat (44) bonded to a face of the backing
sheet, in which the clear coat forms the exterior surface of the
transferred paint coat and the color coat is bonded between the
clear coat and the face of the backing sheet, and in which the
exterior surface of the clear coat substantially retains the
gloss transferred to it from its casting sheet;

25 thermoforming the backing sheet and the composite paint
coat thereon to form a three-dimensionally shaped preformed
laminate (116); and

30 placing the preformed laminate in a mold and molding
a synthetic resinous substrate material (118) to the preformed
laminate to form an exterior vehicle body panel (130) with a
finished exterior automotive paint coat;

35 the clear coat comprising a material that substantially
retains said gloss level during the thermoforming step; the
backing sheet having sufficient thickness and sufficient
elongation to absorb defects present in the substrate material
to retain an essentially defect-free gloss on the clear coat
surface following adherence of the laminate to the substrate
material; the finished composite paint coat providing sufficient

appearance and durability properties for use as an exterior automotive paint coat.

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The process according to claim 1, characterized in that the laminate (116) is thermoformed at a temperature greater than about 270°F, and the composite paint coat (44) elongates greater than about 40% during the thermoforming step while still retaining said gloss level and said exterior automotive appearance and durability properties.

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The process according to claim 1, characterized in that the clear coat (45) comprises a fluorinated polymer and acrylic resin-containing material.

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The process according to claim 3, characterized in that the clear coat (45) comprises a thermoplastic paint system in which the fluorinated polymer is selected from the group consisting of polyvinylidene fluoride, and copolymers and terpolymers of vinylidene fluoride.

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The process according to claim 4, characterized in that the dried clear coat (45) contains less than about 70% polyvinylidene fluoride and less than about 50% acrylic resin, by weight of the total acrylic resin and PVDF solids present in the clear coat.

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The process according to claim 1, characterized in that the paint coat (44) has the minimum levels of gloss, distinctiveness-of-image, QUV, gasoline resistance, cleanability, acid resistance, hardness, abrasion resistance and impact strength, substantially as defined in the automotive specifications for exterior automotive paint finishes described 35 herein.

7. The process according to claim 1, characterized in that
the preformed laminate (116) is molded to the substrate material
5 (118) by injection cladding, reaction injection molding, or
thermoset sheet molding techniques.

8. The process according to claim 1, characterized in that
the clear coat (45) applied to the casting sheet (42) comprises
10 a thermoplastic paint system which includes polyvinylidene
fluoride and an acrylic resin, in which the polyvinylidene
fluoride is dispersed in a solution of the acrylic resin.

9. The process according to claim 1, characterized in that
the clear coat (45) applied to the casting sheet (42) comprises
15 a thermoplastic paint system comprising a solution of
polyvinylidene fluoride and acrylic resin.

10. The process according to claim 9, characterized in that
the finished paint coat (44) has a 60° gloss, level greater than
about 75 gloss units and a distinctiveness-of-image level greater
20 than about 80 units.

11. The process according to claim 1, characterized in that
the backing sheet (72) is a semirigid sheet with a thickness in
25 the range from about 10 mils to about 40 mils.

12. The process according to claim 1, characterized in that
the backing sheet (72) is made from a material selected from the
30 group consisting of ABS, polyester, amorphous nylon, and
thermoplastic polyolefins, including polypropylene and
polyethylene.

13. The process according to claim 1, characterized by
35 including applying a thin film of wax to the casting sheet (42)
prior to casting the clear coat (45) on the casting sheet.

14. The process according to claim 1, characterized in that
a graphics pattern is printed between the clear coat (45) and the
5 color coat (46).

15. The process according to claim 1, characterized by a
pigment contained in the backing sheet (72).

10 16. The process according to claim 1, characterized by
metallic flakes contained in the color coat (46), in which the
flakes are aligned linearly when coated on a carrier film.

15 17. The process according to claim 1, characterized in that
a water soluble protective coating on the exterior surface of the
paint coat (44).

20 18. The process according to claim 17, characterized by the
protective coating is overstamped on the clear coat (45).

25 19. The process according to claim 1, characterized in that
the thermoforming step is carried out by avoiding contact between
the thermoforming apparatus (112) and the clear coat (45) side
of the backing sheet (72).

20 20. A thermoformable laminate for use in forming an
exterior portion of an exterior car body panel, the laminate
comprising a thin, semirigid backing sheet made from a synthetic
resinous material, and an automotive quality paint coat bonded
30 to a face of the backing sheet, in which the paint coat includes
a synthetic resinous coating in dry thin film form having an
exterior surface with a predetermined gloss level transferred to
it from a high gloss casting sheet, the paint coat having
sufficient elongation and resistance to deglossing such that the
35 laminate is thermoformable into a highly contoured three-
dimensional shape while the paint coat substantially retains said

5 predetermined gloss level during thermoforming and provides predetermined appearance and durability properties sufficient to be useful as an exterior automotive paint coat following thermoforming of the laminate.

10 21. The article according to claim 20 in which the laminate can be thermoformed at a temperature of at least about 270°F, and the paint coat elongates greater than about 40% during thermoforming at said thermoforming temperature while still retaining said gloss level and said appearance and durability properties.

15 22. The article according to claim 20 in which the paint coat comprises a fluorinated polymer and acrylic resin-containing paint system with thermoplastic properties, in which the paint coat has been coated on a casting sheet and dried and then transferred from the casting sheer to the backing sheet.

20 23. The article according to claim 20 in which the paint coat comprises a thermoplastic paint system which includes polyvinylidene fluoride and an acrylic resin.

25 24. The article according to claim 23 in which the dried paint coat contains less than about 70% polyvinylidene fluoride and less than about 50% acrylic resin, by weight of the total PVDF and acrylic resin components contained in the paint coat.

30 25. The article according to claim 20 in which the paint coat comprises a pigmented synthetic resinous material with thermoplastic properties.

35 26. The article according to claim 20 in which the paint coat comprises an exterior clear coat and an underlying color coat bonded to the clear coat.

27. The article according to claim 26 in which the color
coat contains a highly dispersed pigment, and in which the clear
5 coat comprises a thermoplastic coating principally containing a
fluorinated polymer and an acrylic resin.

28. The article according to claim 27 in which the clear
coat is a thermoplastic paint system which consists essentially
10 of about 50% to about 70% polyvinylidene fluoride and about 30%
to about 50% acrylic resin; and in which the acrylic resin
component comprises polymethyl methacrylate, polymethyl
methacrylate, or mixtures thereof, including copolymers thereof.

29. The article according to claim 28 in which the color
coat also consists essentially of about 50% to about 70%
polyvinylidene fluoride and about 30% to about 50% acrylic resin;
and in which the acrylic resin component comprises polymethyl
methacrylate, polyethyl methacrylate, or mixtures thereof,
including copolymers thereof.

30. The article according to claim 20 in which the paint
coat on the thermoformed laminate has at least the minimum levels
of gloss, distinctiveness-of-image, QUV, hardness, impact
25 resistance, cleanability, acid resistance, gasoline resistance,
and abrasion resistance, substantially as defined in the
automotive specifications for exterior automotive paint finishes
described herein.

31. The article according to claim 20 in which the paint
coat includes a fluorinated polymer selected from the group
consisting of polyvinylidene fluoride, and copolymers and
terpolymers of vinylidene fluoride.

32. The article according to claim 20 in which the paint coat has a 60° gloss level greater than about 75 gloss units and
5 a distinctiveness-of-image level greater than about 80 units.

33. The article according to claim 20 in which the backing sheet is a semirigid sheet with a thickness in the range from about 10 mils to about 40 mils.

10 34. The article according to claim 20 in which the backing sheet is made from a material selected from the group consisting of ABS, polyester, amorphous nylon, thermoplastic polyolefins, including polypropylene and polyethylene.

15 35. The article according to claim 20 including a wax film applied to the outer face of the clear coat from the casting sheet.

20 36. The article according to claim 20 in which a graphics pattern is printed between the paint coat and backing sheet and is visible through the paint coat.

25 37. The article according to claim 20 including a pigment contained in the backing sheet.

38. The article according to claim 20 including a metallic flake paint layer contained in the paint coat.

30 39. The article according to claim 20 including a water soluble protective coating on the exterior surface of the paint coat.

35 40. An exterior plastic vehicles, the panel having automotive quality paint coat resinous thermoformable backing

body panel for motor a synthetic resinous bonded to a synthetic sheet to form a laminate in which the exterior surface of the 5 paint coat has exterior automotive gloss and distinctiveness-of- image levels, and in which the laminate has been thermoformed into a three-dimensional shape and adhered to a plastic substrate to form said plastic exterior body panel, the paint coat having sufficient elongation and resistance to deglossing to have 10 substantially maintained said gloss and distinctiveness-of-image levels during thermoforming, the backing sheet having sufficient thickness and elongation to have absorbed defects in the substrate material, thereby providing said paint coat on the finished body panel with an essentially defect-free surface with 15 the appearance and durability properties sufficient for exterior automotive use.

41. The panel according to claim 40 in which the paint coat comprises a thermoplastic fluorinated polymer and acrylic resin- containing paint system.

42. The panel according to claim 40 in which the finished paint coat has the minimum levels of gloss, distinctiveness-of- image, QUV, gasoline resistance, cleanability, acid resistance, 25 hardness, abrasion resistance, and impact strength, substantially as defined in the automotive specifications for exterior automotive paint finishes described herein.

43. The panel according to claim 40 in which the paint coat 30 comprises an exterior clear coat and an underlying color coat bonded to the clear coat.

44. The panel according to claim 43 in which the clear coat comprises a fluorinated polymer and acrylic resin-containing 35 material with thermoplastic properties.

45. The panel according to claim 40 in which the paint coat includes a fluorinated polymer selected from the group consisting of polyvinylidene fluoride, and copolymers and terpolymers of vinylidene fluoride.

46. The panel according to claim 40 in which the paint coat has an 80° gloss level greater than about 75 gloss units and a distinctiveness-of-image level greater than about 80 units.

47. The panel according to claim 40 in which the backing sheet is a semirigid sheet with a thickness in the range from about 10 mils to about 40 mils.

48. The panel according to claim 40 in which the backing sheet is made from a material selected from the group consisting of ABS, polyester, amorphous nylon, and thermoplastic polyolefins including polypropylene and polyethylene.

49. The panel according to claim 40 including a wax film applied to the outer face of the clear coat from the casting sheet.

50. The panel according to claim 40 in which the preformed laminate is molded to the substrate material by injection cladding, reaction injection molding, or thermoset sheet molding techniques.

51. The panel according to claim 40 in which a graphics pattern is printed between the paint coat and backing sheet to be visible through the paint coat.

52. The panel according to claim 40 including a pigment contained in the backing sheet.

53. The panel according to claim 40 including metallic flakes contained in the paint coat.

5 54. The panel according to claim 40 including a water soluble protective coating on the paint coat.

10 55. An exterior motor vehicle body panel comprising a plastic substrate, and a laminate on the exterior of the substrate, and a three-dimensionally thermoformed paint coat comprising a thermoplastic fluorinated polymer and acrylic resin-containing paint system that provides an exterior surface on said panel sufficient for exterior automotive use following thermoforming of said paint coat, and in which the amounts of the fluorinated polymer and acrylic resin contained in the paint system are sufficient to resist deglossing of the paint coat during the thermoforming step so that a gloss level is provided in the finished panel, together with sufficient appearance and durability properties for exterior automotive use.

15 56. The panel according to claim 55 in which the fluorinated polymer is selected from the group consisting of polyvinylidene fluoride, and copolymers and terpolymers of vinylidene fluoride.

20 57. The panel according to claim 55 in which the finished paint coat has a 60° gloss level greater than about 75 gloss units and a distinctiveness-of-image greater than about 80 units.

25 58. The panel according to claim 55 in which the paint coat has the minimum levels of gloss, distinctiveness of image, QUV, hardness, impact resistance, cleanability, acid resistance, gasoline resistance, and abrasion resistance, substantially as 30 defined in the automotive specifications for exterior automotive 35 paint finishes described herein.

59. The panel according to claim 55 in which the backing sheet is a semirigid sheet with a thickness in the range from 5 about 10 mils to about 40 mils.

60. The panel according to claim 55 in which the backing sheet is made from a material selected from the group consisting of ABS, polyester, amorphous nylon, and thermoplastic 10 polyolefins, including polypropylene and polyethylene.

15 61. The panel according to claim 55 in which the step of adhering the preformed laminate to the substrate material comprises injection cladding, reaction injection molding, or sheet molding compound techniques.

20 62. A method of manufacturing a plastic exterior body panel for a motor vehicle having a paint coat with exterior automotive appearance and durability properties, the method comprising:

25 forming a laminate comprising a semirigid synthetic resinous backing sheet having a synthetic resinous paint coat adhered to a face of the backing sheet by dry transfer from a casting sheet, in which an exterior automotive gloss level is transferred to the exterior surface of the paint coat from the casting sheet;

thermoforming the laminate into a three-dimensional shape; and

30 placing the formed laminate in a mold and molding a plastic substrate material to the formed laminate to bond the laminate to the substrate and form a plastic car body panel with a finished paint coat;

35 in which the material comprising the paint coat substantially retains said gloss level during the thermoforming step; and

in which the backing sheet has sufficient thickness and elongation to absorb defects from the substrate material, so that

the finished paint coat retains said gloss level during the step
of molding the laminate to the substrate panel, the finished
5 paint coat providing the appearance and durability properties
sufficient for exterior automotive use.

10 63. The method according to claim 62 in which the paint
coat comprises a fluorinated polymer and acrylic resin-containing
material.

15 64. The method according to claim 62 in which the paint
coat is cast as a thermoplastic paint system comprising a
solution of polyvinylidene fluoride and acrylic resin.

20 65. The method according to claim 64 in which the paint
coat has a gloss level greater than about 75 gloss units and a
distinctiveness-of-image level greater than about 80 units.

25 66. The method according to claim 62 in which the paint
coat is cast as a thermoplastic paint system which includes
polyvinylidene fluoride and an acrylic resin, and in which the
polyvinylidene fluoride is dispersed in a solution of the acrylic
resin.

30 67. The method according to claim 62 in which the laminate
is adhered to the substrate by injection cladding, reaction
injection molding, or thermoset sheet molding techniques.

35 68. The method according to claim 62 in which the backing
sheet is a semirigid sheet with a thickness in the range from
about 10 mils to about 40 mils.

69. The process according to claim 62 in which the
thermoforming step is carried out by avoiding contact between the
thermoforming apparatus and the paint coat on the backing sheet.

70. A process for applying a paint coat, suitable for exterior automotive use, to a plastic exterior body panel of a 5 motor vehicle, the process comprising the steps of:

10 applying a clear coat of a solution of vinylidene fluoride and acrylic resin in thin film form onto a surface of a flexible casting sheet, and drying the clear coat on the casting sheet, the surface of the sheet having a specular reflectance for transferring to the surface of the dried clear 15 coat a gloss level sufficient for exterior automotive use;

20 casting a color coat of a pigmented solution of vinylidene fluoride and acrylic resin in thin-film form and drying the color coat;

25 transferring the dried clear coat and color coat to a semirigid backing sheet of a synthetic resinous material to form a composite paint coat bonded to a face of the backing sheet, in which the clear coat forms the exterior surface of the transferred paint coat and the color coat is bonded between the clear coat and the face of the backing sheet, and in which the exterior surface of the clear coat substantially retains the gloss transferred to it from the casting sheet;

30 thermoforming the backing sheet and the composite paint coat thereon to form a three-dimensionally shaped preformed 25 laminate; and

35 adhering the preformed laminate to a synthetic resinous substrate material to form an exterior vehicle body panel;

the clear coat substantially retaining said gloss level during the thermoforming step; the backing sheet having sufficient thickness and sufficient elongation to absorb defects 30 present in the substrate material to retain an essentially defect-free gloss on the clear coat surface following adherence of the laminate to the substrate material; the composite paint coat providing sufficient appearance and durability properties 35 for use as an exterior automotive paint coat.

71. The process according to claim 70 in which the
paint coat on the thermoformed laminate has a gloss level greater
5 than about 75 gloss units and a distinctiveness-of-image level
greater than about 80 units.

72. The process according to claim 70 in which the
substrate is adhered to the laminate by injection cladding,
10 reaction injection molding, or sheet molding compound techniques.

73. The process according to claim 70 in which the backing
sheet is a semirigid sheet with a thickness in the range from
about 10 mils to about 40 mils.

15 74. The process according to claim 70 in which the backing
sheet is made from a material selected from the group consisting
of ABS, polyester, amorphous nylon, thermoplastic polyolefins,
including polypropylene and polyethylene.

20 75. The process according to claim 70 in which the paint
coat is cast as a solution of polyvinylidene fluoride and acrylic
resin.

25 76. The process according to claim 70 in which the finished
paint coat has the minimum levels of gloss, distinctiveness-of-
image, QUV, gasoline resistance, cleanability, acid resistance,
hardness, abrasion resistance, and impact strength, substantially
30 as defined in the automotive specifications for exterior
automotive paint finishes described herein.

77. The process according to claim 70 in which the color
coat includes metallic flakes aligned linearly, and the flakes
have an average thickness of less than about 2000 Angstroms.

78. The process according to claim 77 in which the metallic flakes have a head-on brightness value greater than about 140 units.

79. The process according to claim 1 in which the color coat includes metallic flakes aligned linearly, and the flakes have an average thickness of less than about 2000 Angstroms.

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80. The process according to claim 79 in which the metallic flakes have a head-on brightness value greater than about 140 units.

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